(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(54) Title: LOW-POWER BROADCAST RECEIVER
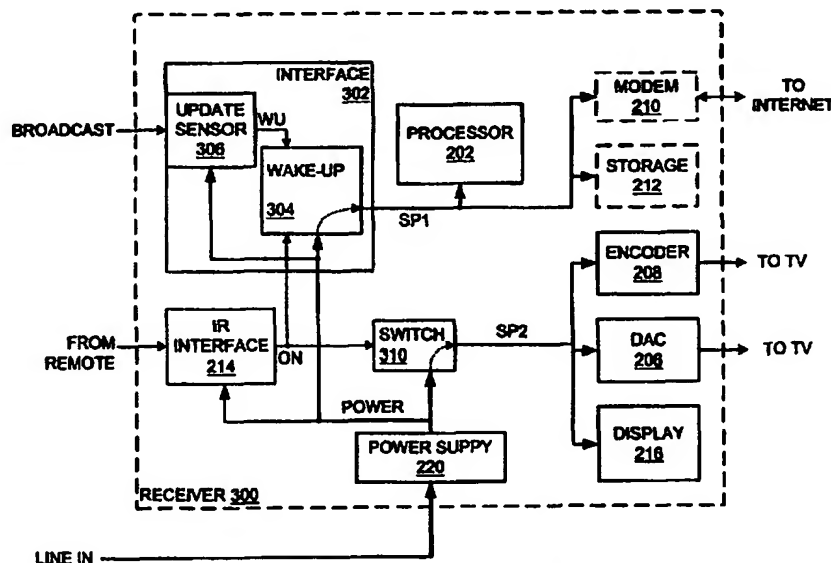
(57) Abstract: Broadcast receivers (300) operate in a power-saving standby mode while retaining the ability to receive broadcast program, software, and firmware updates. The most power hungry circuits are deprived of power in the standby mode using a wake-up switch (304) controlled by an update sensor (306) that actively monitors the broadcast channel in the standby mode. If the receiver (300) receives an update-pending indication while in the standby mode, then the wake-up switch (304) provides power to those components needed to receive the update without indicating a power-on condition to the user.

## LOW-POWER BROADCAST RECEIVER

Robert A. Unger

5  CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C. §119(e)(1) of the Provisional Application filed under 35 U.S.C. §111(b) entitled "Wake Up Methods for Equipment in the Stand-by Mode," Serial No. 60/237,567 filed on October 3, 10  2000.

BACKGROUND

Figure 1 (Prior Art) is a diagram of a broadcast television system 100, including a broadcast headend 102 15  connected via a broadcast network to a number of receivers 104. The broadcast network can be wired (e.g., a cable system), wireless, or a combination of the two. Broadcast headend 102 optionally includes a server (not shown) maintained by a broadcaster to store digital information for 20  broadcast. Similar servers can be maintained by other entities and can be made available to receivers 104 via a separate broadcast medium or a direct connection, such as via a modem or satellite connection.

Each receiver 104 has a corresponding display, often a 25  conventional television set 106. Each receiver 104 connects to its respective television set 106 via an audio-video link 110. Users control receivers 104 via a user-input device, typically an infrared remote control 108 or a control panel (not shown) on their respective receivers 104.

30  Figure 2 is a block diagram of a typical digital receiver 104. A digital processor 202 is the "brains" of receiver 104. Processor 202 typically includes a number of components,

including a central processing unit (CPU) and memory, for
example.  Processor 202 has many variations, depending
primarily upon the desired functionality.  The internal
workings of processor 202 are outside the scope of this
5    disclosure.  Those interested in additional information about
a typical set-top box may refer to U.S. Patent No. 5,940,074
entitled "Remote Upgrade of Software Over a Network," which is
incorporated herein by reference.

An infrared interface 214 receives instructions from an
10   infrared remote control.  A simple display 216 provides the
user with a visual indication of e.g. whether receiver 104 is
powered on and, if so, the channel to which broadcast
interface circuit 204 is tuned.  Processor 202 may present
additional information to the user via the attached video
15   display.  Receiver 104 optionally includes a modem 210 for
connecting to the Internet and some form of local mass storage
212, such as a disk drive.

Processor 202 receives data derived from broadcast video
signals by a broadcast-interface circuit 204.  Broadcast
20   interface circuitry 204 includes one or more tuners that
discriminate one signal from among a number of incoming
broadcast signals and remove the associated carrier frequency.
Interface circuitry 204 digitizes the resulting audio and
video data and conveys the resulting digital information to
25   processor 202.

Processor 202 processes the information from interface
circuit 204 as necessary to present appropriately formatted
audio and video data to an audio digital-to-analog converter
206 and a video encoder 208, respectively.  The resulting
30   signals are then conveyed to television 106 or some other
display.

2

Receivers 104 receive periodic updates from broadcast
headend 102.  For example, a broadcaster may send each
receiver 104 an updated program guide or a software update.
Some components of receiver 104 must be powered up to receive
5  broadcast content; unfortunately, this means much of the
receiver is always powered up, even when the user is not
watching television, and has therefore turned off receiver
104.  In the depicted example, a power supply 220 provides
power continuously at least to broadcast interface circuit
10  204, processor 202, and IR interface 214.  In point of fact,
turning "off" common receivers similar to the ones described
here typically removes power only from user display 216:
turning off the user display comforts frugal consumers, but
saves little power.
15      Leaving most of receiver 104 on at all times wastes power
and money.  To make matters worse, receivers of the type
described herein are proliferating, and are in the process
contributing to an epidemic of power shortages.  There is
clearly a need for more power-efficient broadcast receivers.
20

SUMMARY
        The present invention is directed to broadcast receivers
capable of operating in a power-saving standby mode while
retaining the ability to receive broadcast program, software,
25  and firmware updates.  The receivers have a broadcast
interface that incorporates an update sensor adapted to sense
broadcast updates.
        The receiver includes a wake-up switch, controlled by the
update sensor, that deprives the most power hungry circuits of
30  power in the standby mode.  The update sensor, a relatively
power efficient circuit, remains active at all times.  User-

controlled input circuits, such as an infrared receiver or power switch, also remain active at all times.

If the receiver receives a wake-up instruction in the standby mode, then the sensor closes the wake-up switch to
5 provide power to those components needed to receive the update. In one embodiment, components not required for the update, such as the display, an audio DAC, and a video encoder, are not powered on during the update. This aspect of the invention saves power and avoids startling unsuspecting
10 users by automatically turning on their displays and speakers.

Receivers in accordance with one embodiment include a second power switch that selectively delivers power to those components not controlled by the wake-up switch. If the user instructs the receiver to turn on, then the wake-up switch and
15 second power switch both close (if they are not already closed) to provide power to the entire receiver. A display on the receiver typically provides a visual indication that the receiver is on, and audio and video signals provide contents for display on an associated display device, such as a
20 television.

If the user instructs the receiver to turn off during receipt of an update, then only the second power switch opens, leaving power to those components needed to receive the update. If, on the other hand, the user instructs the
25 receiver to turn off in the absence of an update, then both switches open, leaving the receiver in the standby mode.

The scope of the invention is defined by the claims, and not by this summary.


30 BRIEF DESCRIPTION OF THE FIGURES

Figure 1 (Prior Art) is a diagram of a broadcast television system 100.

Figure 2 (Prior Art) is a block diagram of a typical receiver 104.

Figure 3 depicts a receiver 300 in accordance with the present invention.

5      Figure 4 depicts an embodiment of broadcast interface 302.

Figure 5 depicts an embodiment of sensor 306 that enables the broadcaster to selectively awake only a select number of specified receivers.

10

DETAILED DESCRIPTION

Figure 3 depicts a receiver 300 in accordance with one embodiment of the present invention.  Receiver 300 has many components in common with the conventional receiver 104 of

15  Figures 1 and 2, like components labeled using the same numbers.  Unlike the conventional receiver, however, receiver 300 is adapted to operate in a power-saving standby mode while retaining the ability to receive broadcast program, software, and firmware updates.  Most of the data and control paths are

20  unnecessary for understanding the present invention, and have therefore been eliminated for simplicity.

In accordance with the invention, receiver 300 includes a broadcast interface 302 with a wake-up switch 304 and an update-sensor 306.  Instead of a direct connection to power

25  supply 220, power is applied to components employed in receiving updates via wake-up switch 304.  Wake-up switch 304 thus deprives the most power-hungry circuits in receiver 300 of power in the standby mode.  Update sensor 306, a relatively efficient circuit, remains active at all times.  IR interface

30  214 also receives power at all times, and is therefore prepared to respond to power-on instructions from the user.

5

If receiver 300 receives a wake-up instruction while in the standby mode, then update sensor 306 provides a wake-up signal on line WU to wake-up switch 304. In response, switch 304 closes to provide power on switched-power line SP1 to

5 those components needed to receive the update, such as processor 202. In the depicted embodiment, components not required for the update, such as display 216, audio DAC 206, and video encoder 208, are not powered on during receipt of the update. This aspect of the invention saves power and

10 avoids startling unsuspecting users by automatically turning on their televisions and receivers.

IR interface 214 has a control output ON connected to a second power switch 310 and broadcast interface 302. If the user instructs receiver 300 to turn on, via IR interface 214

15 or an optional switch (not shown) on receiver 214, for example, then the control signal on line ON closes wake-up switch 304 to provide power to those components needed to receive the incoming signal, such as processor 202, display 216, audio DAC 206, and video encoder 208. The signal on line

20 ON also closes switch 310 to provide power to user display 216, audio DAC 206, and video encoder 208. Closing switch 310 provides a visual indication of the "on" condition and presents the requisite signals to the associated display, e.g., television 106. In one embodiment, receiver 300

25 provides switched line-in voltage to a socket (not shown) on receiver 300 to control power applied to television 106 or some other component.

If the user issues a power-off instruction, typically using a remote control to communicate with IR interface 214,

30 then the control signal on line ON opens switches 304 and 310 to remove power from the components connected to power supply 220 via switched-power lines SP1 and SP2. This action places

receiver 300 in a standby mode; power is still applied to IR
interface 214 and broadcast interface 302: update-sensor 306
remains on to detect the presence of updates, such as a new
program guide or a software or firmware upgrade.

5       Conventional wake-up circuits, such as those used to
activate computer monitors from a standby mode, provide power
in response to signals presented to the wake-up circuit.
These conventional circuits are not used in receiver 300
because broadcast signals are generally always present.

10  Update sensor 306 is therefore adapted to differentiate
between signals indicative of a pending update and other
broadcast signals.

        Figure 4 depicts an embodiment of broadcast interface
302.  Broadcast interface 302 includes a conventional tuner

15  400 capable of discriminating one signal from among a number
of incoming broadcast signals and removing the associated
carrier frequency.  A conventional digitizer 402 then
digitizes the resulting video signal and conveys the resulting
data to processor 202.

20      Tuner 400 and digitizer 402 collectively use a
substantial amount of power.  Tuner 400 and digitizer 402 are
therefore connected to power supply 220 (Figure 3) via wake-up
switch 304 so tuner 400 and digitizer 402 do not draw power in
the standby mode.

25      In the depicted embodiment, wake-up switch 304 includes
an OR gate 406 connected to a conventional power switch 410,
typically a relay.  Sensor 306 in turn includes a simple tuned
circuit adapted to monitor a wake-up signal associated with
one broadcast carrier frequency.  In one example, sensor 306

30  produces an enabling logic-one output signal to OR gate 406 if
the amplitude of the broadcast wake-up signal rises above a
predetermined level for a period of time sufficient to reject

7

noise spikes, the rise in amplitude representing a wake-up
instruction.  If sensor 306 produces a logic one on one input
of OR gate 406, then OR gate 406 produces a logic one output
signal that closes power switch 410.  Broadcast interface 302

5   thus applies power via the switched power line SP1 to whatever
components are required to receive a subsequently broadcast
update.

        Sensor 306 does not close switch 310 (Figure 3) when
awakening receiver 300 from the stand-by mode.  In the absence

10  of power from switch 310, display 216 remains off and receiver
300 does not provide audio or video signals to the attached
television or other display device.  Thus, from the user's
perspective, receiver 300 is in a standby mode.  This feature
of the invention is important, as users might otherwise be

15  startled or annoyed when their receiver and/or television
automatically turns on without their instruction to do so.
Receiver 300 might indicate the standby mode to the user;
alternatively, receiver 300 might simply appear to be powered
off.

20      Figure 5 depicts an embodiment of sensor 306 that enables
the broadcaster to awaken only a select number of specified
receivers using, in one embodiment, a very low bit-rate
asynchronous serial transmission.  This version of sensor 306
includes a simple AM tuner 500, a digitizer 502, a shift

25  register 504, a receiver identifier 506 unique to each
receiver and/or unique to the level of programming to which
the receiver is entitled, a collection of exclusive-OR (XOR)
gates 508 serving as a comparator, and an AND gate 510.
Digitizer 502 can be the same or a different component from

30  digitizer 402 of Figure 4.  If a single digitizer is used,
then additional circuitry selects between tuner 400 and tuner

500, depending upon whether receiver 300 is in a standby mode, and the digitizer is supplied power in the standby mode.

In the embodiment of Figure 5, the amplitude of the wake-up signal remains high for the duration of the update.  In

5  other embodiments, control of switch 304 passes to processor 202 once power is supplied from switch 304.  Processor 202 then decides when to return receiver 300 to the standby mode. In another embodiment, processor 202 is always powered up, providing an intelligent means of responding to wake-up

10 instructions.

As before, tuner 500 is tuned to a carrier frequency that the broadcaster uses to convey wake-up signals.  The wake-up signal includes an identifier intended to match all or part of the number stored in receiver identifier 506.  The contents of

15 shift register 504 are continuously compared with the number stored in receiver identifier 506.  If all bits match, the 64 XNOR gates 508 provide 64 logic ones to the 64 input terminals of an AND gate 510.  AND gate 510 combines these output signals to produce a logic one output, thereby closing switch

20 304.  If two corresponding bits on the inputs of XNOR gates 508 do not match, however, then XNOR gates 508 produce at least one logic zero output.  Any logic zero to AND gate 510 causes AND gate 510 to output a logic zero, leaving switch 304 open and receiver 300 in the standby mode.

25  .The example of Figure 5 assumes receiver 300 is in the standby mode to start with.  If the receiver is powered upon receipt of the wake-up signal, power is already applied to the circuits required to receive the update.  An additional connection (not shown) between the output of AND gate 510 and

30 processor 202 can be used to enable or block the incoming update, depending upon whether the receiver ID matched the incoming identifier.

9

Display 216 (Figure 2) is always responsive to user
input, turning on and off in response to commands from IR
interface 214. To avoid confusing the user, wake-up sensor
306 cannot turn display on or off automatically. Display 216
5   does not indicate a power-on condition when awakened by a
wake-up instruction so users are not confused to see receiver
300 automatically power up; similarly, if the user elects to
turn off receiver-unit 300 during an upgrade, receiver 300
remains active but switch 304 opens, turning off encoder 208,
10   DAC 206, and display 216. Receiver 300 enters the standby
mode upon completion of the update. In other embodiments,
display 216 or some other visual indicators, such as an LED,
remain powered and indicate that receiver 300 is in a standby
mode.

15      While the present invention has been described in
connection with specific embodiments, variations of these
embodiments will be obvious to those of ordinary skill in the
art. For example, other components, such as modem 210, can be
configured to initiate the "on" signal to awaken receiver 300.
20   Therefore, the spirit and scope of the appended claims should
not be limited to the foregoing description.

CLAIMS

What is claimed is:

1.   A broadcast receiver (300) comprising:

5      a.   a power supply (220) having a power-supply output
            terminal (POWER); and

       b.   a broadcast interface circuit (302) including:

            i.   an interface-circuit input terminal adapted to
                 receive a plurality of broadcast communications
10               signals (BROADCAST) on the tuner input
                 terminal, each signal modulated about a
                 selected carrier frequency;

            ii.  a tuner (400) having a tuner input terminal
                 connected to the interface input terminal,
15               wherein the tuner is adapted to select one of
                 the signals and provide the selected signal on
                 a tuner output terminal;

            iii. a wake-up sensor (306) having a sensor input
                 terminal connected to the interface input
20               terminal and a wake-up-sensor output terminal,
                 the wake-up sensor being adapted to produce a
                 wake-up signal on the wake-up-sensor output
                 terminal in response to a first selected
                 signal; and

25          iv.  a wake-up switch (304) having a wake-up-switch
                 input terminal connected to the power-supply
                 output terminal (POWER), a wake-up-switch
                 output terminal, and a wake-up-switch control
                 terminal connected to the wake-up-sensor output
30               terminal.

2.    The receiver (300) of claim 1, the wake-up sensor (306)
      further including a second tuner (500) tuned to a carrier
      frequency associated with the first selected signal.

5     3.    The receiver (300) of claim 2, the wake-up sensor (306)
      further comprising a digitizer (502) connected between
      the tuner (500) and the wake-up-switch control terminal.

4.    The receiver (300) of claim 1, wherein the tuner (400)
10    includes a power terminal (SP1) connected to the wake-up-
      switch output terminal.

5.    The receiver (300) of claim 1, further comprising a
      display (216) capable of indicating a power-on condition
15    for the receiver (300), the display (216) having a power-
      input terminal connected to the power supply (220) via a
      second switch (310).

6.    The receiver (300) of claim 5, wherein the display (216)
20    does not indicate a power-on condition in response to the
      wake-up signal.

7.    The receiver (300) of claim 1, further comprising a
      processor (202) having a processor power terminal
25    connected to the wake-up-switch output terminal.

8.    A broadcast communication network comprising:
      a.    a broadcast head-end (102) adapted to broadcast a
            plurality of signals about a corresponding plurality
30          of carrier frequencies, the signals including an
            occasional wake-up instruction;

         b.     a plurality of receivers (300) adapted to receive the plurality of signals, each receiver including:

             i.    a power supply (220) having a power-supply output terminal (POWER); and

5            ii.   a broadcast interface circuit (302) including:

                    (1)   an interface-circuit input terminal adapted to receive a plurality of broadcast communications signals on the tuner input terminal, each signal

10                          modulated about a selected carrier frequency;

                    (2)   a wake-up sensor (304, 306) having a sensor input terminal connected to the interface input terminal and a wake-up-

15                          sensor output terminal, the wake-up sensor being adapted to produce a wake-up signal on the wake-up-sensor output terminal in response to first selected signal; and

                    (3)   a wake-up switch (304, 410) having a wake-

20                          up-switch input terminal connected to the power-supply output terminal (POWER), a wake-up-switch output terminal, and a wake-up-switch control terminal connected to the wake-up-sensor output terminal.

25

   9.    The network of claim 8, the wake-up sensor (304, 306) further including a tuner (500) tuned to a carrier frequency associated with the first selected signal.

30 10.   The network of claim 9, the wake-up sensor (304, 306) further comprising a digitizer (502) connected between the tuner (500) and the wake-up-switch control terminal.

11. The network of claim 9, the interface circuit (302) including a second tuner (400) having a tuner input terminal connected to the interface input terminal,

5    wherein the second tuner (400) is adapted to select one of the signals and provide the selected signal on a tuner output terminal.

12. The network of claim 11, further comprising a processor

10    (202), the interface circuit further comprising a digitizer (502) connected between the tuner (500) and the processor (202).

13. The network of claim 11, wherein the second tuner (400)

15    includes a power terminal connected to the wake-up-switch output terminal.

14. The network of claim 8, further comprising, for each receiver (300), a display (216) capable of indicating a

20    power-on condition for the receiver (300), the display (216) having a power-input terminal connected to the power supply (220) via a second switch (310).

15. The network of claim 14, wherein the display (216) does

25    not indicate a power-on condition in response to the wake-up instruction.

16. A method of reducing power usage in a broadcast receiver (300), the method comprising:

30    a.   monitoring, in a standby mode, a user-input device (108) for a power-on instruction;

14

b.   indicating a power-on condition for the receiver
     (300) in response to the power-on instruction;

c.   monitoring the user-input device (108) for a power-
     off instruction;

5    d.   indicating a standby condition for the receiver
          (300) in response to the power-off instruction; and

e.   monitoring, with the receiver (300) in the standby
     condition, a broadcast communication channel for a
     wake-up instruction.

10

17.  The method of claim 16, further comprising, upon receipt
     of the wake-up instruction, providing power to a first
     portion of the receiver (300) and indicating a standby
     condition for the receiver (300) while receiving a
15   receiver update.

18.  The method of claim 17, further comprising, upon receipt
     of a power-on instruction in the standby condition,
     providing power to the first portion and a second portion
20   of the receiver (300) and indicating the power-on
     condition.

19.  The method of claim 16, wherein indicating a power-on
     condition includes providing a video signal to a video
25   display device (216).

20.  The method of claim 16, wherein the user-input device
     (108) comprises an infrared receiver.

30 21.  A broadcast receiver (300) comprising:
     a.   means (214) for monitoring a user-input device (108)
          for a power-on instruction;

15

   b.   display means (216) for indicating a power-on
        condition for the receiver (300) in response to the
        power-on instruction;

   c.   means (214) for monitoring the user-input device for
5       a power-off instruction;

   d.   means responsive to the power-off instruction for
        indicating a power-off condition for the receiver
        (216); and

   e.   means (306) for monitoring a broadcast communication
10      channel for a wake-up instruction with the receiver
        in the power-off condition.


22.  The receiver (300) of claim 21, wherein the means for
     monitoring the broadcast communication channel includes a
15   power switch (410) for providing power to a processor
     (202) in response to the wake-up instruction.


23.  The receiver of claim 22, wherein the display means (216)
     indicates the power-off condition when the power switch
20   (410) provides power to the processor (202) in response
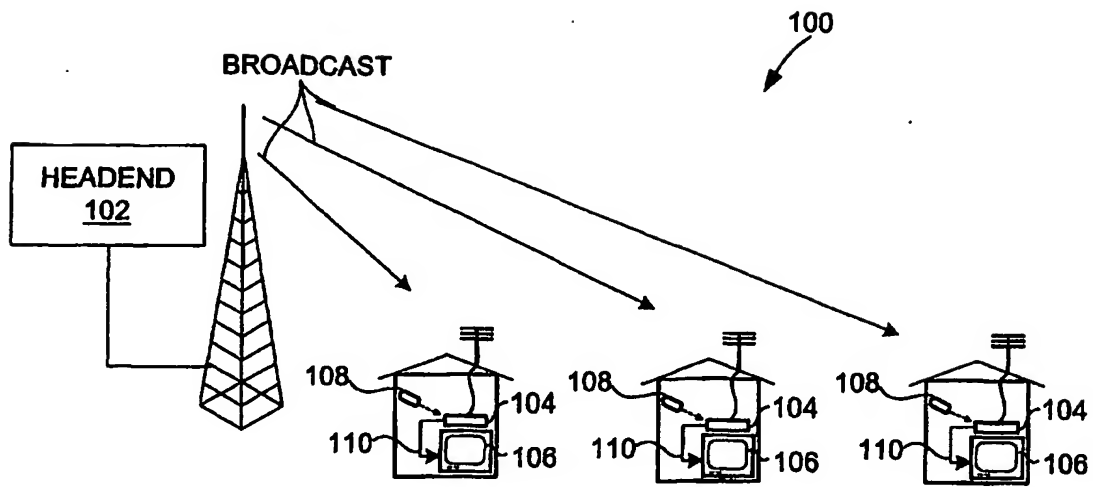     to the wake-up instruction.
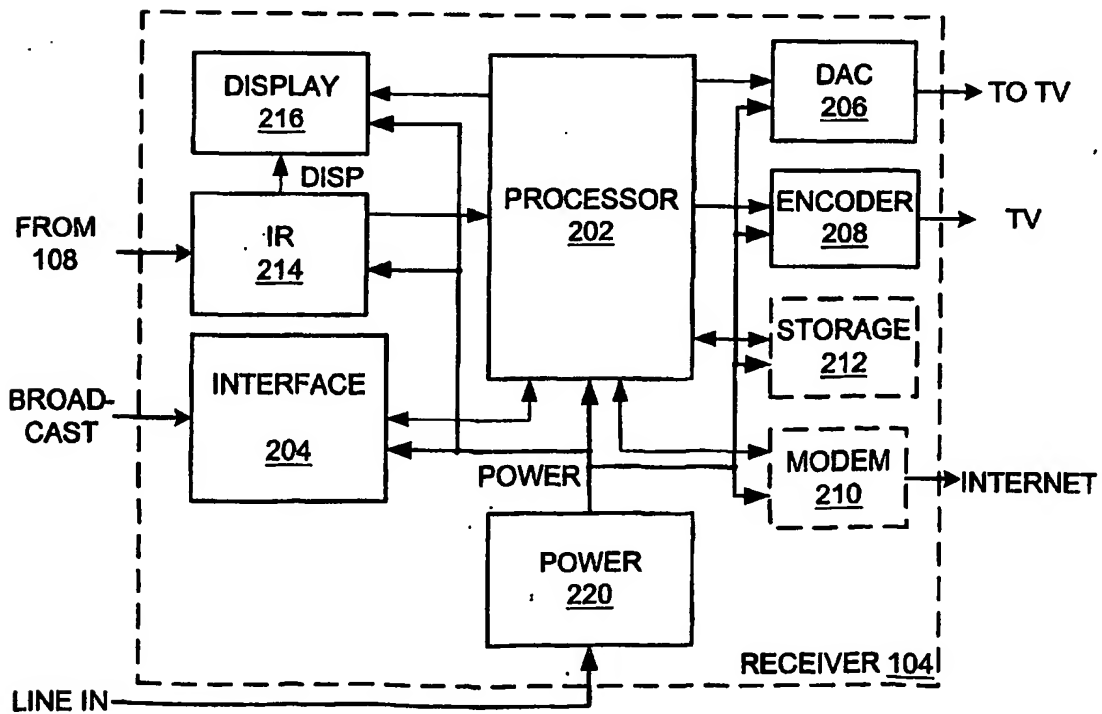
1/3



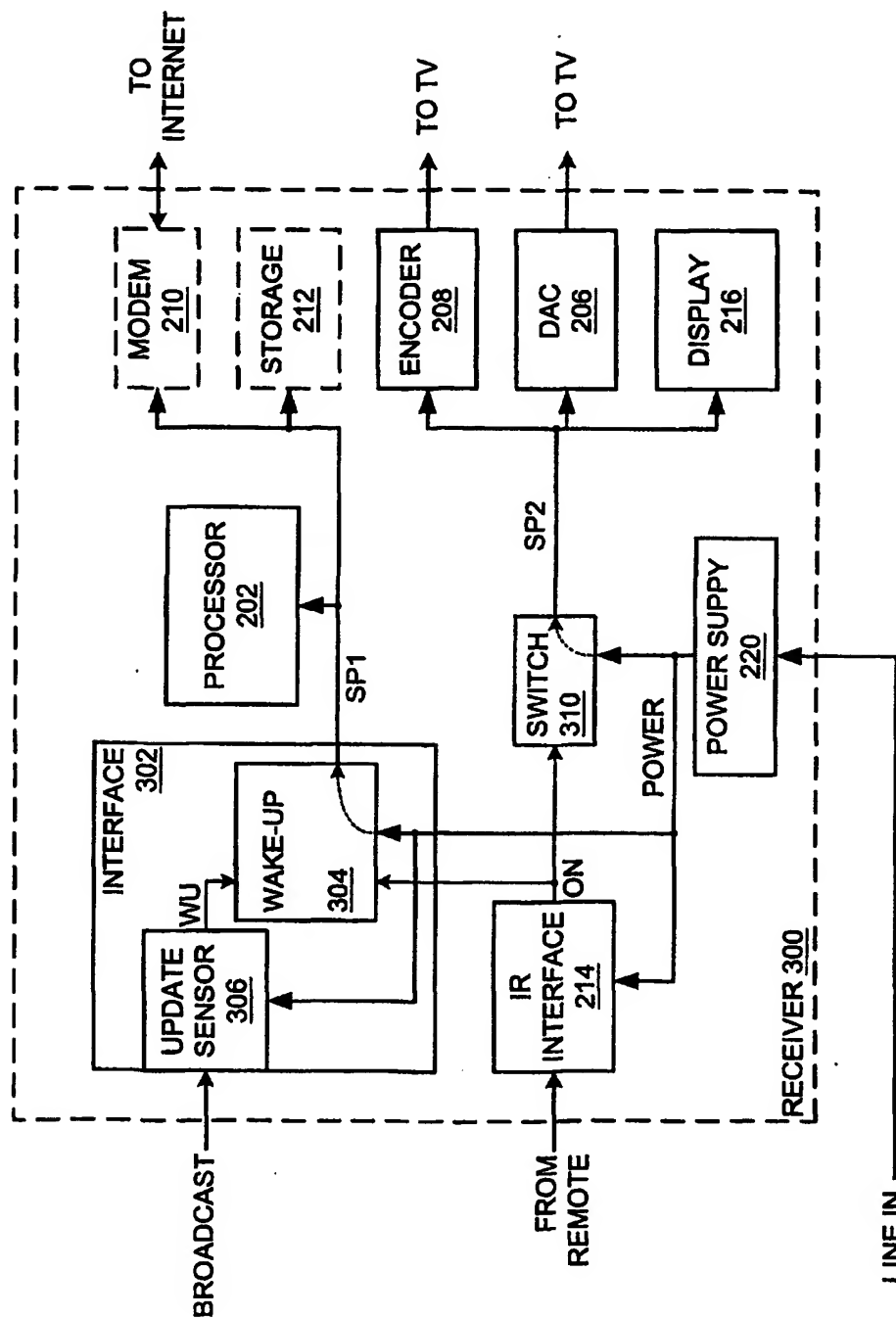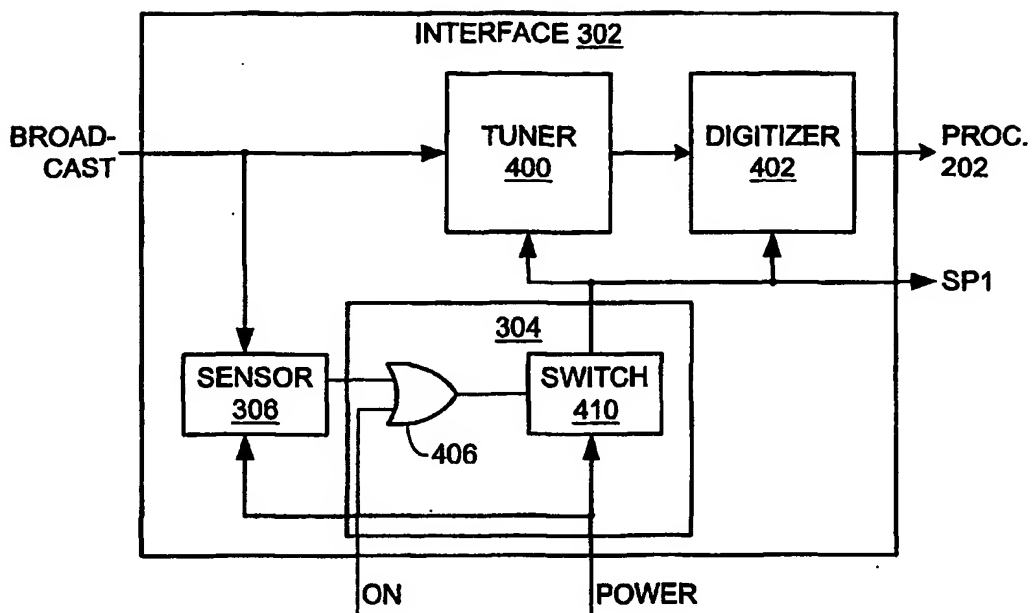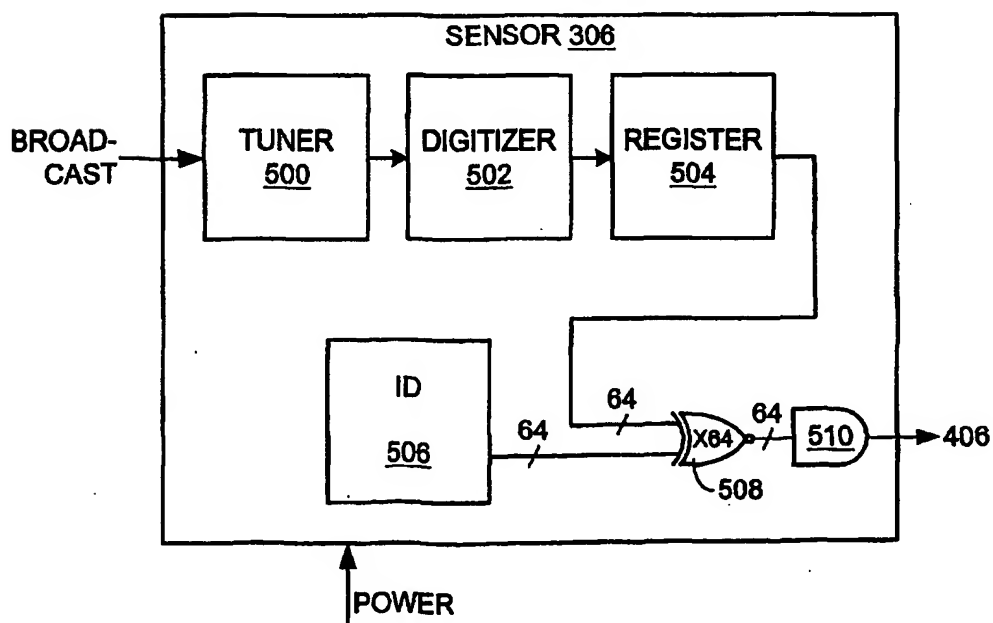FIG. 1 (PRIOR ART)



FIG. 2 (PRIOR ART)

FIG. 3

3/3



FIG. 4



FIG. 5

# INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : H04N 05/63, 07/00

US CL : 348/552, 730, 554; 345/211, 212

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/552, 730, 554, 705, 706, 558; 345/211, 212, 214; 455/38.3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 4,858,006 A (SUZUKI et al) 15 August 1989 (15.08.1989), entire document. | 1-23 |
| X,P | US 6,285,406 B1(BRUSKY) 04 September 2001 (04.09.2001), entire document. | 1-23 |
| A | US 5,894,331 A (YANG) 13 April 1999 (13.04.1999), entire document. | 1-23 |
| A | US 5,296,932 A (LONG) 22 March 1994 (22.03.1994), entire document. | 1-23 |
| A | US 5,625,882 A (VOGK et al) 29 April 1997 (29.04.1997), entire document. | 1-23 |
| A | US 5,555,032 A (KUNG) 10 September 1996 (10.09.1996), entire document. | 1-23 |
| A | US 5,870,613 A (WHITE et al) 09 February 1999 (09.02.1999), entire document. | 1-23 |
| A | US 6,054,981 A (KIMOTO et al) 25 April 2000 (25.04.2000), entire document. | 1-23 |
| A | US 5,883,669 A (HITACHIYA et al) 16 March 1999 (16.03.1999), entire document. | 1-23 |

☒ Further documents are listed in the continuation of Box C.   ☐ See patent family annex.

| * | Special categories of cited documents: |
|---|---|
| "A" | document defining the general state of the art which is not considered to be of particular relevance |
| "E" | earlier application or patent published on or after the international filing date |
| "L" | document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) |
| "O" | document referring to an oral disclosure, use, exhibition or other means |
| "P" | document published prior to the international filing date but later than the priority date claimed |

| "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
|---|---|
| "X" | document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| "Y" | document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "&" | document member of the same patent family |

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 01 December 2001 (01.12.2001) | 02 JAN 2002 |

| Name and mailing address of the ISA/US | Authorized officer |
|---|---|
| Commissioner of Patents and Trademarks<br>Box PCT<br>Washington, D.C. 20231<br>Facsimile No. (703)305-3230 | Linus H. Lo<br>Telephone No.; 703-305-4039 |

Form PCT/ISA/210 (second sheet) (July 1998)

## C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

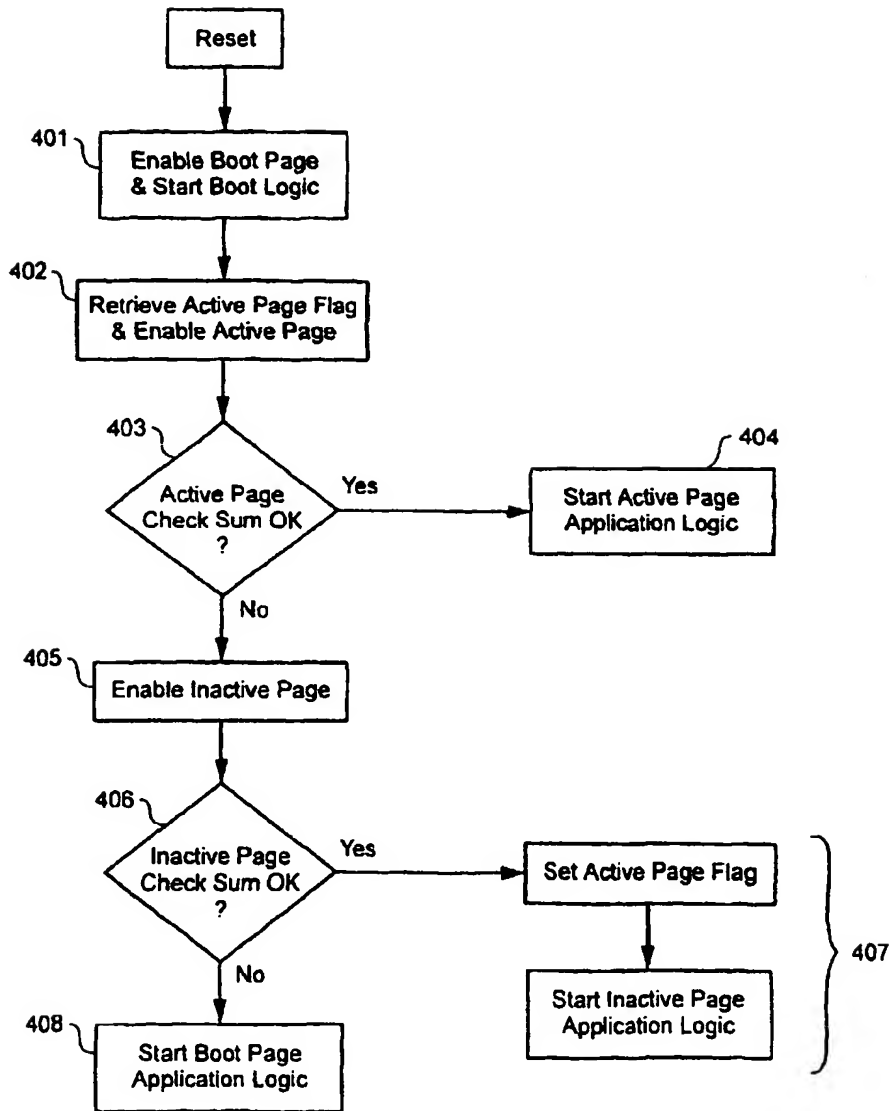| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 5,170,159 A (KAWABATA et al) 08 December 1992 (08.12.1992), entire document. | 1-23 |
| A | US 5,903,765 A (WHITE et al) 11 May 1999 (11.05.1999), entire document. | 1-23 |
| A | US 5,249,164 A (KOZ) 28 September 1993 (28.09.1993), entire document. | 1-23 |

# Figure 4

```
                    ┌──────────┐
                    │  Reset   │
                    └──────────┘
                          │
                          ▼
401          ┌────────────────────────┐
             │   Enable Boot Page     │
             │   & Start Boot Logic   │
             └────────────────────────┘
                          │
                          ▼
402          ┌────────────────────────┐
             │ Retrieve Active Page Flag│
             │  & Enable Active Page   │
             └────────────────────────┘
                          │
                          ▼
403              ◇ Active Page ◇    Yes      404 ┌──────────────────┐
                 ◇ Check Sum OK ◇ ──────────────▶│ Start Active Page│
                 ◇      ?       ◇                │ Application Logic│
                      │                          └──────────────────┘
                      │ No
                      ▼
405          ┌────────────────────────┐
             │   Enable Inactive Page  │
             └────────────────────────┘
                          │
                          ▼
406              ◇ Inactive Page ◇   Yes    ┌──────────────────┐
                 ◇ Check Sum OK ◇ ─────────▶│ Set Active Page Flag│ ┐
                 ◇       ?      ◇           └──────────────────┘  │
                      │                              │            │ 407
                      │ No                           ▼            │
                      ▼                     ┌──────────────────┐  │
408   ┌────────────────────┐               │ Start Inactive Page│ ┘
      │  Start Boot Page    │               │ Application Logic │
      │  Application Logic  │               └──────────────────┘
      └────────────────────┘
```

Table 1   (continued)

| Code | Data | Argument | Description |
|------|------|----------|-------------|
| DnldEth | - | cmd | Controls In-band download of firmware using the data channel (see detailed description below).<br>cmd=0 : get status<br>cmd=1 : In-band prep.<br>cmd=2 : In-band verify<br>cmd=3: : In-band copy<br>cmd=4 : compare buffer to FLASH memory 8<br>cmd=5 : query "In-band copy done?" |
| SwapApp | - | - | Verifies contents of the inactive page and sets the Active Page Flag to point to it. |

[0047]   As noted above, it is not possible to change the active page or write data to the FLASH memory 8 while it is active. However, because the microprocessor 6 can only execute one command at a time, execution of any command automatically causes any other concurrent processes to be temporarily held, and process-specific state-variables stored in a buffer (conventionally provided in the microprocessor 6 for that purpose) pending completion of the command currently being executed. In accordance with the present invention, this (conventional) operation of the microprocessor 6 is exploited to enable manipulation and writing of data to the FLASH memory 8 during run-time of the application logic 24 from the FLASH memory 8. Accordingly, the invention provides a layered operational structure described below with reference to Figs. 5a and 5b. In the embodiment illustrated in Fig. 5a, a block of application logic 24 is copied to RAM and executed by a shell routine. In the embodiment illustrated in Fig. 5b, a block of application logic 24 is copied to RAM 10 during start-up of the communication device 1, and remains resident in RAM 10 pending execution under control of the shell routine. For ease of illustration, both layer structures are illustrated in Figs. 5a and 5b by way of example algorithms which save data to the inactive page of the FLASH memory 8. It will be understood, however, that other operations can also be performed, as desired, using the layered structure of the invention. Referring now to Fig. 5a, saving data to the inactive page of the FLASH memory 8 proceeds as follows:

501.   Reception of an API command (e.g. from the update server 16) causes execution of a shell routine from the FLASH memory 8;

502.   The shell routine copies a block of application logic 24 into RAM 10, and then triggers execution of the copied application logic. Execution of the copied application logic from RAM 10 automatically causes other ongoing processes (controlled by application logic 24 in the FLASH memory 8) to be temporarily suspended, thereby releasing the FLASH memory 8 without terminating other processes.

503.   The copied application logic in RAM 10 causes the microprocessor 6 to enable the inactive page of the FLASH memory 8, performs one or more operations on the inactive page of the FLASH memory 8 (e.g. writing bytes of an updated firmware load 20); and then causes the microprocessor 6 to enable the active page of the FLASH memory 8 before terminating.

504.   Termination of the copied application logic in RAM 10 returns control to the shell routine running in the FLASH memory 8, and releases the RAM 10 occupied by the copied application logic. The shell routine may issue a response to the API command, prior to terminating.

[0048]   Following termination of the shell routine, suspended processes can resume on the basis of their respective state variables. The shell routine can copy the entire application logic 24 to RAM 10, or only that portion required to execute the functionality accessed by the respective API command, as desired.

[0049]   Fig 5b illustrates an alternative layered structure. In this case, a block of application logic 24 is copied into RAM 10 during start-up of the communication device 1, rather than by the shell routine. The copied block of application logic 24 remains resident in RAM 10, and is triggered by a command (possibly including one or more arguments) from the shell routine. Preferably, the copied block of application logic 24 completes a single operation step (i.e. it does not contain decision or process control logic) so that process control remains with the shell routine. This minimizes the size and run-time of the copied block of application logic 24, so that disruption of other concurrent processes (which are interrupted while the copied block of application logic 24 is running from RAM 10) is also minimized.

[0050]   In the example illustrated in Fig. 5b, the copied block of application logic 24 is a "Copy-address" function

## INTERNATIONAL SEARCH REPORT

Continuation of B. FIELDS SEARCHED Item 3:
East
search terms: tuner, stand$, power, wake$